

100-10  
1N 64  
8451  
10  
Lew-  
NASA Case No. 15,734-1

PRINT FIG. 1

NOTICE

The invention disclosed in this document resulted from research in aeronautical and space activities performed under programs of the National Aeronautics and Space Administration. The invention is owned by NASA and is, therefore, available for licensing in accordance with the NASA Patent Licensing Regulation (14 Code of Federal Regulations 1245.2).

To encourage commercial utilization of NASA-owned inventions, it is NASA policy to grant licenses to commercial concerns. Although NASA encourages nonexclusive licensing to promote competition and achieve the widest possible utilization, NASA will consider the granting of a limited exclusive license, pursuant to the NASA Patent Licensing Regulations, when such a license will provide the necessary incentive to the licensee to achieve early practical application of the invention.

Address inquiries and all applications for license for this invention to NASA Patent Counsel, Lewis Research Center, Mail Stop LE-LAW, 21000 Brookpark Road, Cleveland, OH 44135. Approved NASA forms for application for nonexclusive or exclusive license are available from the above address.

Serial No.: 08/288,364

Filed Date: 8/9/94

LeRC

NASA CASE NO. LEW-15,734-1

AWARDS ABSTRACT

A METHOD OF POISSON'S RATION IMAGING WITHIN A MATERIAL PART

The present invention is directed to a method of displaying the Poisson's ratio image of a material part. In the present invention longitudinal data is produced using a longitudinal wave transducer and shear wave data is produced using a shear wave transducer. The respective data is then used to calculate the Poisson's ratio for the entire material part. The Poisson's ratio approximations are then used to display the image.

Inventor: Don J. Roth  
Evaluators: Gene E. Shook/Vernon Williams  
Employer: NASA LeRC

NASA CASE NO. LEW-15,734-1

**A METHOD OF POISSON'S RATIO IMAGING  
WITHIN A MATERIAL PART**

ORIGIN OF THE INVENTION

5       The invention described herein was made by an employee of the United States Government and may be manufactured and used for the Government for governmental purposes without the payment of any royalties thereon or therefore.

10      FIELD OF THE INVENTION

      The present invention is directed to a method and apparatus for determining Poisson's ratio variation within a material part so that it can be displayed for analysis. Poisson's ratio variations within a material part have been found to contribute  
15      to the structural failure of a material part. Poisson's ratio variations in the form of a pictorial map within the material part were previously unattainable without using intrusive methods. Therefore, in performing prior art numerical analysis the Poisson's ratio was assumed to be constant, thereby creating  
20      a less accurate numerical analysis of the material part.

      It is, therefore, an object of the present invention to interrogate the material part using an improved contact scan method that permits dry inspection.

      It is a further object of the invention to create accurate  
25      numerical analysis by providing the Poisson's variation within the material part.

It is still a further object of the invention to display the Poisson's variation within the material part by imaging.

5

#### DESCRIPTION OF RELATED ART

U.S. Patent No. 3,302,044 relates to an ultrasonic probe which is able to detect both longitudinal waves and shear waves. U.S. Patent No. 4,213,147 is directed to ultrasonic image processing of B scan ultrasonic images. U.S. Patent No. 4,967,401 relates to an analysis of seismic data used to locate hydrocarbon reservoirs by determining lithographic parameters including Poisson's ratio. U.S. Patent No. 5,038,787 is directed to an ultrasonic inspection system directed for the evaluation of bone structures which takes into account Poisson's ratio.

10  
15

#### SUMMARY OF THE INVENTION

20

25

The present invention is directed to a method of determining the Poisson's ratio variation within a material part. A self-aligning transducer assembly is used to perform the ultrasonic contact scan. The assembly enables dry coupled contact scanning of the material part. The assembly is designed using buffer rod faces so that the transducer head will make contiguous contact with the material part. The transducer assembly is then moved repeatedly across the surface of the material part to attain a full image of the entire material part.

The measurements are used to determine the poisson's ratio variation within a material part. The Poisson's ratio variation is desired when doing finite element analysis of the material part for more accurate modeling. In the present disclosure, a Poisson's ratio image is generated by taking discrete measurements of both the ultrasonic longitudinal wave velocity and the shear wave velocity of the material part. The Poisson's ratio is computed as  $v = [(v_l^2/2 - v_s^2)/(v_l^2 - v_s^2)]$  for each point selected. The poisson value for each point is mapped to a gray scale and imaged using the scale values.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The objects, advantages, and novel features of the invention will be more fully apparent from the following detailed description when read in connection with the accompanying drawings in which:

Fig 1. displays a drawing of the self-aligning transducer assembly for ultrasonic contact scanning.

Fig 2. displays a photo-micrograph of the poisson ratio variation within a material part.

Fig 3. displays a flow chart of the method used to measure the poisson ratio variation within a material part.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1. displays the transducer sensor assembly. A  
5 mounting plate 10 supports the assembly so that the entire  
assembly can be positioned. A load cell 20 attaches the  
mounting plate to the housing of the assembly 30. The housing  
30 retains a sleeve 60 which in turn retains the transducer 50.  
A ball bearing 40 is used to maintain slidable contact between  
10 the load cell 20 and the sleeve 60. A middle ring 70 and a  
bottom ring 90 are separated by bearing balls 100. The complete  
assembly is held together by retainer bands 110 attached to  
retainer pins 80.

Figure 2. displays an image of the Poisson's ratio within  
15 a material part. To obtain the image the ultrasonic probe  
systematically scans each area of the material part.

The image is created by performing several steps detailed  
in the flow chart of figure 3. First an ultrasonic contact scan  
is made over the portion of a sample that is of interest. The  
20 first scan is performed by using a longitudinal wave energy  
transducer as denoted by 120. The scan method performed can  
either be a wet or a dry coupled scan, however the dry coupled  
scan would be more consistent with the spirit of the invention.  
Next a second scan of the sample portion of interest is scanned  
25 using a shear wave energy transducer as denoted by 130. The  
best results are attained if the nominal transducer frequency

used in the longitudinal wave is used in the shear wave. The data from the measurement are used to calculate the longitudinal and shear wave velocities at each scan point as denoted by 140.

5 The Poisson's ratio is then calculated using the formula  $v = [(v_l^2/2 - v_s^2)/(v_l^2 - v_s^2)]$ . The Poisson's ratio value for each measured point is then converted to normalize the value to an integer value between 0 and 255 as denoted by 160. The largest and smallest values of the Poisson's ratio should be set to 255  
10 and 0, respectively to begin the normalization process. As a final step the poisson's image is displayed using an 8-bit(256 value) video image processing system as denoted by 170.

While the preferred embodiment of the invention is disclosed and described it will be apparent that various modifications may  
15 be made without departing from the spirit of the invention or the scope of the subjoined claims.

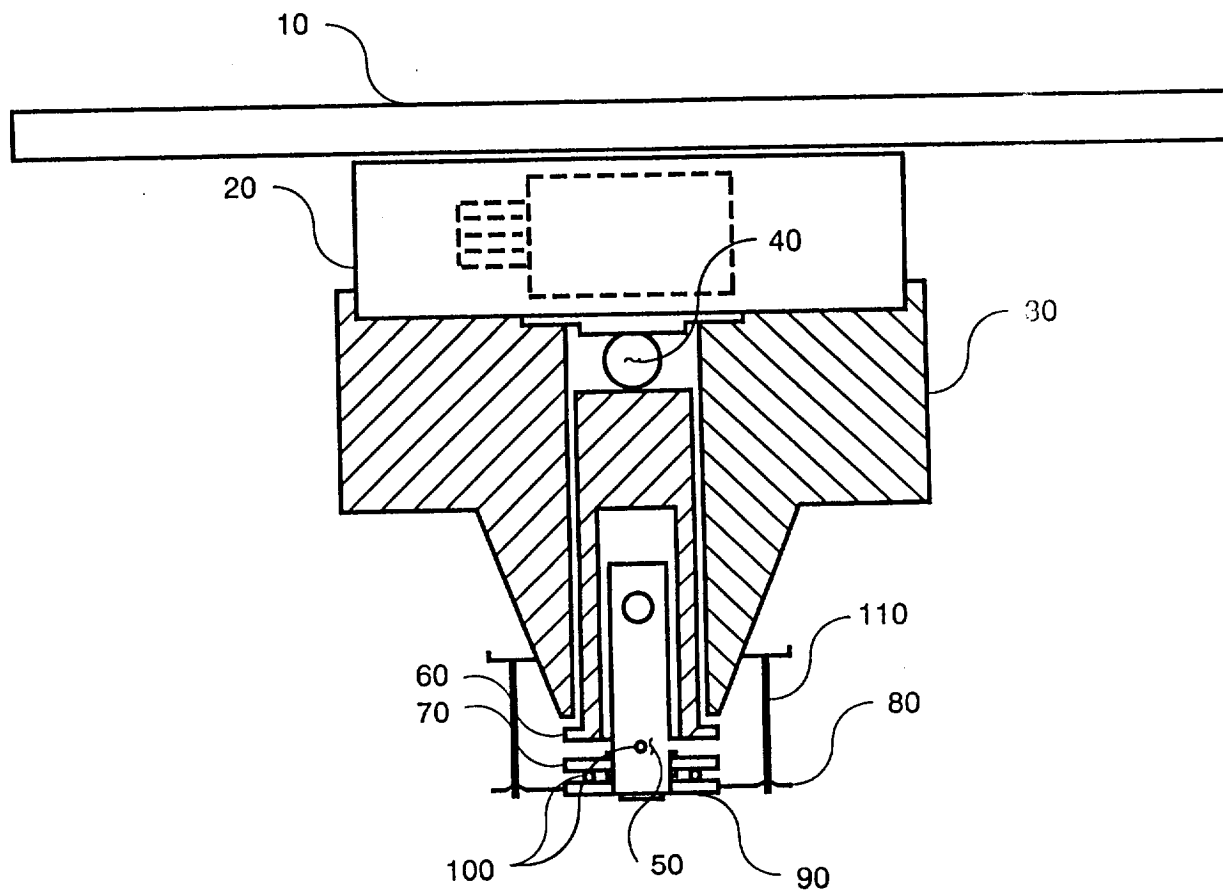


FIG. 1



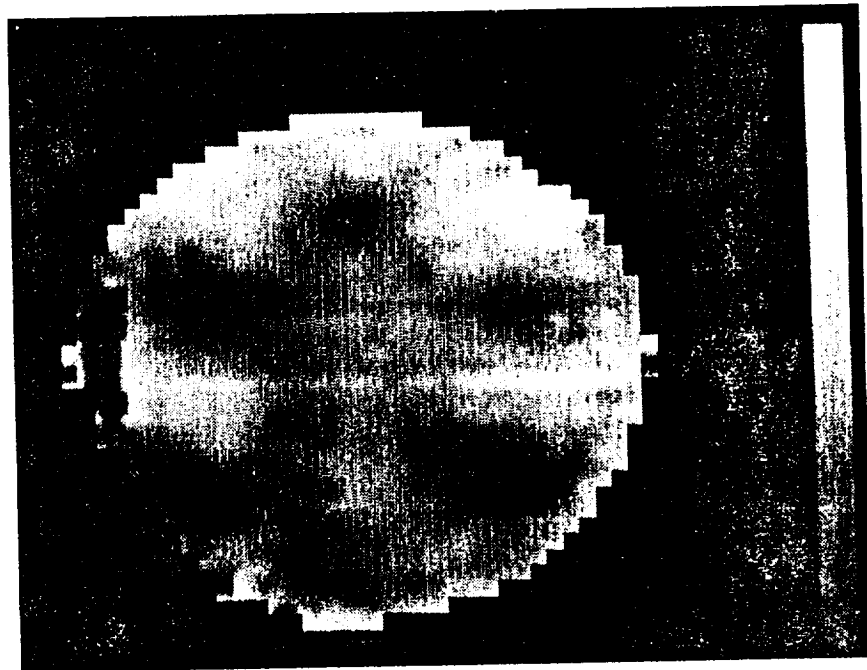


FIG. 2

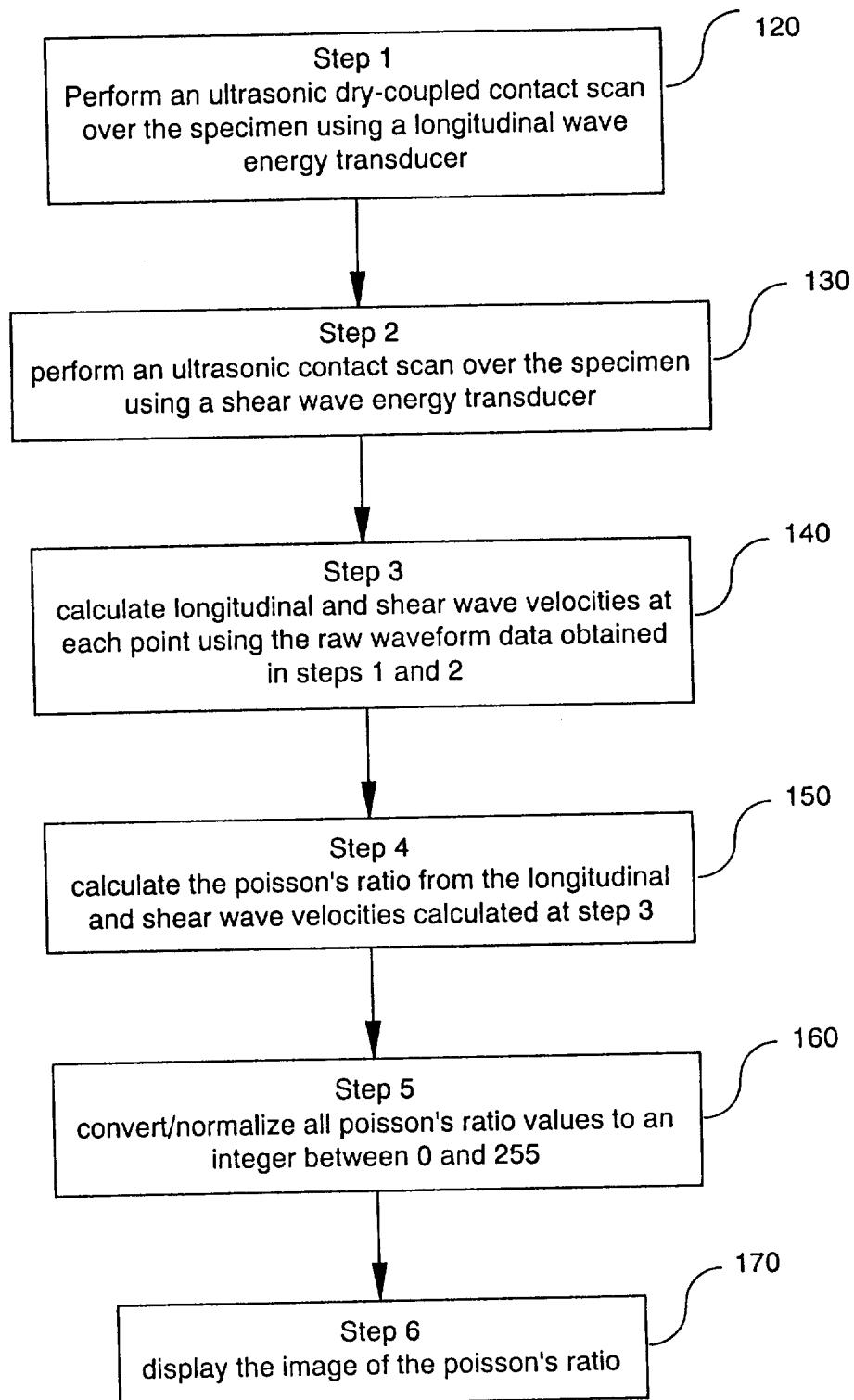


FIG. 3